

Voluntary heart rate reduction following yoga using different strategies

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ABSTRACT

Background/Aims: One month of yoga training has been shown to reduce the pulse rate voluntarily without using external cues. Hence, the present study was designed to understand the strategies used by yoga practitioners and autonomic changes associated with voluntary heart rate reduction.

Materials and Methods: Fifty volunteers (group mean age \pm S.D., 25.4 ± 4.8 years; 25 males) were assessed in two trials on separate days. Each trial was for 12 minutes, with a 'pre' state and 'during' state of 6 minutes each. For both trials the 'pre' state was relaxation with eyes closed. In the 'during' state of Trial I, subjects were asked to voluntarily reduce their heart rate using a strategy of their choice. From their responses to specific questions it was determined that 22 out of 50 persons used breath regulation as a strategy. Hence, in the 'during' state of Trial II, subjects were asked to voluntarily reduce their heart rate by breath regulation.

Results: In the first trial, the heart rate was reduced by an average of 19.6 beats per minute and in the second trial (with breath regulation exclusively) an average decrease of 22.2 beats per minute was achieved.

Conclusions: Hence, the strategy used did not markedly alter the outcome.

Key words: Breath regulation; voluntary heart rate reduction; yoga.

INTRODUCTION

There is an interest in understanding whether visceral and glandular functions can be voluntarily regulated. Many functions which were originally thought to be involuntary are now known to be operantly conditioned.^[1] There are several methods used to train an individual in voluntary regulation of these functions such as biofeedback which uses external cues. In contrast, the ancient Indian science of yoga is believed to help in gaining mastery over the mind and body by awareness of internal sensations, breath regulation and directed attention.^[2]

Earlier studies investigated whether yoga practitioners are in fact able to control functions thought to be mainly, if not entirely, involuntary. For example, experienced yoga

practitioners claimed to be able to stop their heart beating at will. In some practitioners the amplitude of the QRS complex in the electrocardiogram was found to be lower, and was associated with maintained inspiration and signs of raised intra thoracic pressure.^[3] These findings suggested that the yoga practitioners used breath maneuvers to bring about the cardiovascular changes seen in them. However, similar explanations did not apply to another yogi who remained in an underground pit for eight days, with an absence of electrical activity in the EKG during the period.^[4] The findings remained inexplicable to investigators. It was also difficult to explain the ability of practitioners of a Tibetan Buddhist meditation, g-Tum-mo yoga, to increase the temperature of their digits by 5 to 15°C.^[5]

In these reports the yoga practitioners were all experienced and committed to yoga practice. More recently a study was undertaken on novices to yoga practice, to determine whether one month of yoga training would help them to reduce their pulse rate guided by external visual cues.^[6] A group who practiced yoga were compared to a non-yoga control group. The yoga group and the control group were able to achieve a pulse rate reduction of 7.1 beats per minute and 6.0 beats per minute on Day 1, respectively.

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While these values were not significantly different, the pulse rate reduction achieved at the end of one month was a decrease of 23.1 beats per minute for the yoga group compared to a decrease of 5.2 beats per minute recorded in the control group. Both groups were guided by external visual cues during each session. Hence, the results suggested that yoga practice could augment the effect of feedback cues, within a month of learning yoga.

A subsequent study examined the effect of one month of yoga practice on the ability to voluntarily reduce the pulse rate without external cues.^[7] At the start of the study, the lowest pulse rates achieved during a six minute session, were comparable for yoga and control groups. At the end of one month, the yoga group was able to reduce their pulse rate significantly by 6.8 beats per minute without external cues while the control group showed no change. However, the reduction of 6.8 beats per minute without using external cues was considerably less than the reduction of 23 beats per minute observed when external cues were used.^[6]

In the absence of the external cues individuals would have used their own strategies to reduce their pulse rate. Hence, the present study was designed to attempt to understand the strategies used by yoga practitioners during voluntary heart rate reduction, and simultaneously recording changes in heart rate variability (HRV).

MATERIALS AND METHODS

Participants

Fifty volunteers with ages ranging from 18 to 37 years (group mean age \pm S.D. 25.4 ± 4.8 years; 25 males) participated in the study. All of them were residential trainees at different stages of yoga training programs of two years duration. Their average experience of yoga was 16.3 ± 14.0 months. A routine clinical examination showed that they all had normal health. An electrocardiogram (EKG) recording showed that none of them had extra systoles or any abnormality in the EKG. The project was approved by the Institutional Ethics Committee. The study design was explained to the participants who gave their signed consent to participate in this study.

Design of the study

All participants were assessed in two trials on two separate days. Both trials were for 12 minutes. This duration was selected to be comparable with the assessment periods in two earlier studies which examined voluntary pulse rate reduction following yoga.^[6,7] In the earlier studies the pulse rate was measured from the record of the peripheral pulse using a photo electric transducer. For the first trial (Trial I), subjects were asked to sit at ease with their eyes closed, for six minutes. This was the 'pre' state. In the next six minutes subjects were asked to attempt to voluntarily reduce their heart rate. They

were not given any suggestion how to do so and were asked to use a strategy of their choice. This was the 'during' state. At the end of Trial I the subjects were asked to tick (✓) the option which described the strategy they used to reduce their heart rate voluntarily. The questionnaire had 7 choices (and was multiple-choice and open ended). The options from which they had to select any one were: (i) mental imagery, (ii) muscle relaxation, (iii) mental repetition of a syllable, (iv) internal awareness, (v) breath regulation, (vi) meditation, or (vii) any other strategy, which allowed participants to add any other strategy used by them, and hence, was open ended. 44 percent of the subjects (i.e., 22 out of 50) chose breath regulation as the strategy. Hence, for Trial II, the first six minutes (or 'pre' state) was the same as for Trial I. However, for the 'during' state, also of six minutes all subjects were asked to regulate their breath as a possible way to voluntarily reduce their heart rate. For breath regulation subjects were asked to breathe slowly and deeply. Throughout the session both the Trial I and Trial II subjects were asked to sit at ease in a chair and to keep their eyes closed.

Assessments

The electrocardiogram (EKG) was acquired using Ag/AgCl adhesive pre-gelled electrodes (Bio Protech, Korea) and a standard limb lead I configuration. The EKG was recorded using an ambulatory EKG system (Recorders and Medicare Systems ECG 101, Chandigarh, India). The sampling rate was 1024 Hz and data were stored offline for analysis, using a software developed at the Department of Physiology, All India Institute of Medical Sciences, New Delhi, India. The data were visually inspected off-line and noise free data were included for analysis. Data were acquired separately during the 'pre' and the 'during' states of both Trial I and Trial II.

Data extraction

The heart rate was obtained from the interbeat interval. Frequency domain analysis of heart rate variability data was carried out for six minute recordings of both 'pre' and 'during' states. The heart rate variability power spectrum was obtained using Fast Fourier Transform (FFT) analysis. The energy in the heart rate variability series in the following frequency bands was used for analysis., viz., the very low frequency band (VLF; 0.0 – 0.04 Hz), low frequency band (LF; 0.04 – 0.15 Hz), and high frequency band (HF; 0.15 – 0.40 Hz). The low frequency and high frequency band values were expressed as normalized units.^[8] The heart rate was obtained from the interbeat interval and the average heart rate recorded in two six minute states ('pre' and 'during'), as well as the lowest heart rate reached in the 'during' state was noted.

Data analysis

Statistical analysis was done using SPSS (Version 10.0). Values obtained in the 'during' state were compared to

the 'pre' state of a trial, using a t-test for paired data. This was done separately for Trial I and for Trial II. The values compared were the average heart rate and the power of the heart rate variability components (i.e., LF, HF, and VLF, as well as the LF/HF ratio). The least heart rate achieved in the 'during' state of Trial I was compared with the least heart rate achieved in the 'during' state of Trial II.

RESULTS

Trial I

In the 'during' state of Trial I subjects attempted to voluntarily reduce their heart rate and did not use any specific strategy. The average heart rate was lower 'during' compared to 'pre' ($P < 0.01$, paired t-test). There was a significant increase in the low frequency (LF) power 'during' compared to 'pre' ($P < 0.05$, paired t-test). The high frequency (HF) power was significantly less 'during' compared to 'pre' ($P < 0.05$, paired t-test), and the LF/HF ratio was higher 'during' compared to 'pre' ($P < 0.05$, paired t-test). The very low frequency (VLF) power was lower 'during' compared to 'pre' ($P < 0.001$, paired t-test).

Trial II

In the 'during' state of Trial II subjects attempted to voluntarily reduce their heart rate by breath regulation. In the 'during' state the following values were higher, the LF power of the heart rate variability ($P < 0.001$), the LF/HF ratio ($P < 0.001$) and the VLF power ($P < 0.001$). In contrast, the HF power was significantly lower 'during' compared to 'pre' ($P < 0.001$). The least heart rate achieved in the 'during' state of Trials I and II were not significantly different. Groups mean values \pm S.D. are given in Table 1.

DISCUSSION

In the present study on fifty normal volunteers with sixteen months of experience in yoga, participants achieved a significantly lower heart rate during a period of attempting to reduce the heart rate by breath regulation. The decrease was by 22.2 beats per minute (group mean 57.3 ± 7.4 beats per minute) compared to preceding rest periods. When subjects used strategies of their own choice, their

heart rate was lower by 19.6 beats per minute (group mean 60.1 ± 7.5) beats per minute.

The decrease in heart rate achieved when subjects used breath regulation as a strategy to voluntarily reduce their heart rate was comparable to the reduction achieved in an earlier study when subjects used external visual cues and achieved a reduction of 23 beats per minute,^[6] but was considerably more than the decrease of 7.1 beats per minute seen in another group who attempted to decrease their heart rate without external cues. This difference may be related to the fact that the subjects of present study had longer experience of yoga than those assessed earlier (i.e., an average of 16 months as compared to 1 month). Practicing yoga has been shown to improve the regularity of breathing,^[9] reduce physiological arousal,^[10] and increase attention.^[11] Hence, the practice of yoga may facilitate the conditioning of visceral responses by autosuggestion. In the present study participants did use autosuggestion to reduce their heart rate. However, it is possible that though the participants did use their own strategy to reduce the heart rate since they were trained in yoga, self-regulation may have added to the effects seen.

In the present study there was an increase in the LF power in the 'during' states of both Trial I and Trial II compared to the respective 'pre'. The LF band of heart rate variability is chiefly related to sympathetic modulation when expressed as normalized units.^[8] It is also reported that acute increase in the low frequency and total spectrum heart rate variability and in vagal gain were corrected with slow breathing during biofeedback periods.^[12] Also, it was shown that biofeedback training to increase the amplitude of respiratory sinus arrhythmia maximally increases the amplitude of heart rate oscillations at 0.1 Hz, exclusively.^[13] To achieve this, breathing is slowed to a point at which resonance occurs between respiratory induced oscillations and oscillations that naturally occur at this rate. In the present study in both the 'during states' (i.e., of Trial I and Trial II), the subjects modified their breathing, to breathe slower and deeper. For Trial I this was true for 22 out of 50 persons, whereas for Trial II all 50 persons were asked to breathe slowly and deeply. The data of those participants who used breath techniques during

Table 1: Heart rate and heart rate variability components in 'pre' and 'during' states of Trial I and Trial II. values are group mean \pm S.D.

Variables	Trial I		Trial II	
	Pre	During	Pre	During
Heart rate (beats per minute)	82.11 \pm 11.49	79.78 \pm 11.20**	79.59 \pm 7.85	79.56 \pm 7.69
Lowest heart rate achieved (beats per minute)	Not recorded	60.14 \pm 7.45	Not recorded	57.31 \pm 7.40
Low frequency power (n.u)	57.29 \pm 19.29	64.48 \pm 22.54*	53.12 \pm 19.32	81.09 \pm 15.44***
High frequency power (n.u)	42.71 \pm 19.29	35.52 \pm 22.37*	46.88 \pm 19.32	18.91 \pm 15.44***
LF/HF ratio	2.14 \pm 2.14	4.27 \pm 5.29*	1.78 \pm 1.92	9.24 \pm 9.14***
Very low frequency power (ms ²)	31.56 \pm 14.79	22.16 \pm 15.42***	32.96 \pm 13.99	16.13 \pm 12.19***

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$, paired t-test, 'during' compared with 'pre'

both trial periods appeared to show no clear training effect as in Trial 1 the 22 participants showed an average heart rate reduction of 3 beats per minute, from 81.5 (pre) to 78.1 (during). In Trial II there was no change, as the heart rate in 'pre' state was 78.4 and in 'during' state was 78.5. However, the least heart rate achieved in Trial II (55.97) was marginally less than that achieved in Trial I (58.71), suggesting that there may have been some training effect, though the difference was not statistically significant.

The increase in LF power was greater in the 'during' state of Trial II (52.6 percent increase) compared to 'during' state of Trial I (12.6 percent increase). The fact that respiration was not simultaneously monitored is a drawback of the present study. In the absence of such an objective assessment, it is only possible to speculate that the increase in LF power may have been related to slower breath rates. This suggests that the shift to greater LF activity in the 'during' phase of both trials resulted from a change in breath rate to the low frequency range rather than from changes in autonomic balance.

In both 'during' states of the two trials the HF power decreased, compared to the 'pre' as did the LF/HF ratio. When expressed as normalized units efferent vagal activity is a major contributor to the HF band. The LF/HF ratio is correlated with sympatho-vagal balance.^[14] The present results are suggestive of a shift in the autonomic balance, with lower vagal activity and possible sympathetic predominance in the 'during' states. However, in the 'during' states the heart rate was lower than the pre-state. This was not unexpected as subjects were attempting to reduce their heart rates voluntarily. Hence, while the average heart rate in the 'during' states was lower than in the respective 'pre' states; and this did not appear to be due to a change in the autonomic balance. This lack of clarity is due to the fact that the changes in heart rate variability may have been related to a change in breath frequency, and in the absence of a record of respiration this remains unanswerable.

The VLF (very low frequency) power was also lower in the 'during' states of both trials. While the very low frequency power accounts for more than 90 percent of the total power in the 24 – h heart rate power spectrum, the physiological mechanisms underlying the very low frequency power have not been determined.^[15] The VLF power partially reflects thermoregulatory mechanisms, fluctuation in activity of the renin-angiotensin system, and the function of peripheral chemoreceptors.^[14,16] Also, both the respiratory pattern and level of physical activity modulate very low frequency power.^[17,18] Hence, the physiological mechanisms for very low frequency power are not fully understood. For this reason there has been no attempt to discuss the physiological significance of changes in very low frequency power in the present study.

In summary, the present study has shown that yoga practitioners with an average of 16 months of experience in yoga, were effectively able to reduce their heart rates by 19.6 beats per minute when they used strategies of their choice, and were able to achieve a reduction of 22.2 beats per minute when all of them used breath regulation as a strategy for heart rate reduction. The exact mechanisms underlying the change are not known. Further studies, with a simultaneous recording of variables regulated by the autonomic nervous system along with recording the breath frequency would be expected to help in understanding the mechanisms involved. The possible mechanism of such changes in heart appears to be due to enhance respiratory sinus arrhythmia. Yoga training includes variety of physical and psychic maneuver which have capability to enhance respiratory sinus arrhythmia.

The study has three main limitations. (i) there was no control group which used specific strategies to reduce their heart rate voluntarily, and (ii) despite the fact that biofeedback has clinical possibilities in decreasing the blood pressure,^[19] in the present study it was not possible to record the blood pressure, and (iii) participants were not asked whether they used the Valsalva maneuver, which is known to alter the heart rate.^[20] These limitations suggest directions for future studies.

REFERENCES

1. Leukel F. Introduction to physiological psychology. Indian ed. Delhi: CBS Publications. 1985.
2. Taimini IK. The science of yoga. madras: The theosophical publishing house; 1986.
3. Wenger MA, Bagchi BK, Anand BK. Experiments in India on 'voluntary' control of the heart and pulse. *Circulation* 1961;24:1319-25.
4. Kothari LK, Bordia A, Gupta OP. The yogic claim of voluntary control over the heartbeat: An unusual demonstration. *Am Heart J* 1973;86:283-4.
5. Benson H, Lehman JW, Malhotra MS, Goldman RF, Hopkins J, Epstein MD. Body temperature changes during the practice of g-Tum-mo yoga. *Nature* 1982;295:234-5.
6. Telles S, Vani R. Increase in voluntary pulse rate reduction achieved following yoga training. *Int J Stress Manag* 2002;9:235-9.
7. Telles S, Joshi M, Dash M, Raghuraj P, Naveen KV, Nagendra HR. An evaluation of the ability to voluntarily reduce the heart rate after a month of yoga practice. *Integr Physiol Behav Sci* 2004;39:119-25.
8. Task force of the european society of cardiology and the north american society of pacing and electrophysiology, heart rate variability: Standards of measurements, physiological interpretation and clinical use. *Circulation* 1996;93:1043-65.
9. Telles S, Srinivas RB. Autonomic and respiratory measures in children with impaired vision following yoga physical activity programs. *Int J Rehabil Health* 1999;4:117-22.
10. Telles S, Narendran S, Raghuraj P, Nagarathna R, Nagendra HR. Comparison of changes in autonomic and respiratory parameters of girls after yoga and games at a community home. *Percept Mot Skills* 1997;84:251-7.
11. Telles S, Raghuraj P, Maharana S, Nagendra HR. Immediate effect of three yoga breathing techniques on performance on a letter cancellation task. *Percept Mot Skills* 2007;104:1289-96.
12. Lehrer PM, Vaschillo E, Vaschillo B, Lu SE, Eckberg DL, Edelberg R, et al. Heart rate variability biofeedback increases baroreflex gain and peak expiratory flow. *Psychosom Med* 2003;65:796-805.

13. Lehrer PM, Vaschillo E, Vaschillo B. Resonant frequency biofeedback training to increase cardiac variability: Rationale and manual for training. *Appl Psychophysiol Biofeedback* 2000;25:177-91.
14. Malliani A, Pagani M, Lombardi F, Cerutti S. Cardiovascular neural regulation explore in the frequency domain. *Circulation* 1991;84:482-92.
15. Hadase M, Azuma A, Zen K, Asada S, Kawasaki T, Kamitani T, *et al.* Very low frequency power of heart rate variability is a powerful predictor of clinical prognosis in patients with congestive heart failure. *Circulation* 2004;68:343-7.
16. Parati G, Saul JP, Di Rienzo M, Mancia G. Spectral analysis of blood pressure and heart rate variability in evaluating cardiovascular regulation: A critical appraisal. *Hypertension* 1995;25:1276-86.
17. Bernadi L, Valle F, Coco M, Calciati A, Sleight P. Physical activity influences heart rate variability and very-low-frequency components in Holter electrocardiograms. *Cardiovasc Res* 1996;32:234-7.
18. Mortara A, Sleight P, Pinna GD, Maestri R, Prpa A, La Rovere MT, *et al.* Abnormal awake respiratory patterns are common in chronic heart failure and may prevent evaluation of autonomic tone by measures of heart rate variability. *Circulation* 1997;96:246-52.
19. Patel C, North WR. Randomised controlled trial of yoga and biofeedback in management of hypertension. *Lancet* 1975;2:93-5.
20. Looga R. The Valsalva manoeuvre—cardiovascular effects and performance technique: A critical review. *Respir Physiol Neurobiol* 2005;147: 39-49.

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